A New End-Effect-Free Sensor for the Transient Hot Strip Technique

V. Meier, U. Hammerschmidt [C, S] and R. Stosch
Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

R. Model
Physikalisch-Technische Bundesanstalt, Berlin, Germany

In the transient hot strip (THS) technique for the determination of the thermal conductivity and thermal diffusivity of solids, a thin metal strip simultaneously acts as a Joule-heater and a resistance thermometer (a self-heated thermometer). The observed temperature excursion of the strip is the measure of both thermal transport properties mentioned. In contrast to the assumption of the underlying ideal mathematical model the real strip has a finite length. At both of its ends heat may be lost to the electrical leads or gained from them. This interaction impedes the supposed uniform temperature profile along the longitudinal axis of the strip. The resulting systematic error cannot be treated analytically but has to be compensated for experimentally. From the related transient hot wire technique two possible means of compensation are known. The one of them that is superior to the other is the so-called short-and-long cell method. Here, a second wire is used that is most equal to the first one but shorter in length. This technique is now applied to the THS method using a specially designed heater foil: Embedded between two polyimide films there is a meandering electrically conducting pattern of two discrete sections different in length. Thermally the overall pattern appears as a compact strip while electrically each section acts as an individual self-heated thermometer. Their difference in voltage drop, e.g., generated by a Wheatstone-bridge, yields the practically end-effect-free output signal of the new sensor from which the transport properties are derived. In addition to the compensating effect the meandering pattern has a larger electrical resistance than the conventional strip. This favourable property improves the temperature signal significantly. Experimental results on polymethylmethacrylat, Pyrex and a thermal insulation are presented.